PROFESSOR TAIT'S "HEAT"

Heat. By P. G. Tait, M.A., Professor of Natural Philosophy in the University of Edinburgh. (London: Macmillan and Co., 1884.)

A TREATISE on heat by one so eminent, both as physicist and teacher of Physics, needs no apology, and yet no doubt the author is right in stating that his work is adapted to the lecture-room rather than to the study or the laboratory. Freshness and vigour of treatment are its characteristics, and the intelligent student who reads it conscientiously will rise from it not merely with a knowledge of heat but of a good many other things besides.

"If science," says our author (p. 368), "were all reduced to a matter of certainty, it could be embodied in one gigantic encyclopædia, and too many of its parts would then have . . . little more than the comparatively tranquil or, rather, languid interest which we feel in looking up in a good gazetteer such places as Bangkok, Ak-Hissar, or Tortuga." Not a few text-books of science are precisely of the nature of such a guide without its completeness, and while they carry the student successfully to the end of his journey, the way before him is made so utterly deficient in human interest that he reaches his goal with a sigh of relief, and looks back upon his journey with anything but satisfaction—as a task accomplished rather than as a holiday enjoyed. Now the presence of such a human interest is the great charm of the work before us. It may be a fancy on our part, but we cannot help likening our author to the well-known guide of Christiana and her family. Both have been equally successful in the slaughter of those giants whom the older generation of pilgrims had to find out for themselves and encounter alone. But here the likeness ends, for it is quite certain that those who place themselves under the scientific guidance of our author will not be treated like women or children, but they will be taught to fight like men. And surely to combat error is an essential part of the education of the true man of science, for, if not trained up as a good soldier of the truth to defend the king's highway, he will be only too apt to turn freebooter, and gain his livelihood by preying on the possessions of others.

The first chapter contains the fundamental principles. "Heat," says our author, "whatever it may be, is SOMETHING which can be transferred from one portion of matter to another; the consideration of temperatures is virtually that of the mere CONDITIONS which determine whether or not there shall be a transfer of heat, and in what direction the transfer is to take place."

Then follows a preliminary historical sketch of the subject, the result of which is that heat is now proved to be a form of energy. Again: "The mechanism upon which heat-energy depends is (probably at least) approximately known so far as regards heat in a gas and as regards radiant heat. Beyond these we have, as yet, little information on the subject."

The following is a digression by the way:—

"There can be no question about the fact that the *metre* is inconveniently long, and the *kilogramme* inconveniently massive, for the ordinary affairs of life. The average length of the arms of shop-girls, and the average quantity of tea or sugar wanted at a time by a small purchaser, have no conceivable necessary relation to the ten-millionth part of the quadrant of the earth's meridian passing through Paris, or the maximum density of water. But the standard *yard* and *pound* were, no doubt, originally devised to suit these very requirements as regards the average dimensions of the shop-girl or the paying powers of the ordinary customer. Yet this invaluable superiority of our *units* over those of the metrical system is, with an almost over-refinement of barbarism, thrown away at once when we come to multiples or sub-multiples."

It may be desirable to quote the author's own words regarding his classification of different kinds of heat:—

"In the first place, we have absolutely no proof that radiation from the sun is in any of the forms of energy which we call heat while it is passing through interplanetary space. That it is a form of energy, and that it depends upon some species of vibration of a medium, we have absolute proof. But it seems probable that we are no more entitled to call it heat than to call an electric current heat; for, though an electric current is a possible transformation of heat-energy, and can again be frittered down into heat, it is not usually looked upon as being itself heat. Just so the energy of vibrational radiation is a transformation of the heat of a hot body, and can again be frittered down into heat—but in the interval of its passage through space devoid of tangible matter, or even when passing (unabsorbed) through tangible matter, it is not necessarily *heat*."

That this is not a mere question of words may be seen from the following considerations. According to theory, all kinds of radiant heat, whether these have issued from a source of high or from one of low temperature, are in presence of an absolutely black surface at once and entirely converted into absorbed heat. On the other hand, absorbed heat is only entirely converted into radiant heat when the body from which it issues has been cooled down to the absolute zero of temperature, a condition which is practically unapproachable.

The following are the subjects which appear to us to be treated in the most original manner:—Thermo-electricity, combination and dissociation, conduction, convection, and radiation, discussion of isothermals and adiabatic lines. In the development of thermo-electricity and of conduction the author has taken a prominent part, and probably we must blame the late mild winter for our not hearing more about his latest research regarding the effect of pressure upon the point of the maximum density of water.

We cannot do justice to such a book in the course of a short notice like the present; we will therefore content ourselves with a few quotations and remarks. The following (p. 72) is an excellently clear definition of an isotropic body:—

"An isotropic body is one from which, if a small sphere were cut, it would be impossible to tell by any operation on it how it originally lay in the solid—it has, in fact, precisely the same properties in all directions."

In p. 91 an increase in clearness is produced by giving the coefficient of dilatation of mercury at various temperatures under three different heads, namely, mean coefficient of dilatation from 0°, coefficient referred to volume at 0°, true coefficient. The following statement will be found useful to meteorologists:—

"Vertical (convection) currents at definite places may be at once produced either by heating the requisite part of the lower portions of a fluid mass, or by cooling that of the upper portions. But the effects of cooling part of the lower portions, or heating some of the upper, are usually

much less important. Hence the grander phases of *ocean circulation* (except in so far as they depend on winds, and therefore on *atmospheric circulation*) are much more dependent upon polar cold than upon tropical heat. On the other hand, those of atmospheric circulation depend more upon tropical heat than on polar cold. For the great temperature effects are produced mainly at the upper surface of the ocean, and at the lower surface of the atmosphere. Hence, if there were no great modifying causes, we should expect to find (on the whole) the lower water, as well as the lower air, coming from both sides towards the equator, and the upper currents of each flowing to the poles."

Chapter XXI. is entitled "Elements of Thermodynamics." The subject is nevertheless treated in a very complete manner, and is evidently regarded by our author as something in the shape of a *header*. We gather this from the very characteristic invitation to take the leap which is addressed to the student in Art. 381. We shall not, however, repeat the invitation, but rather leave the reader to find it out for himself and then—take the leap.

Let us conclude with one more quotation :—

"We have merely to think of the ideas which we try to express by such words as Time, Space, and Matter, to see that, however far discovery may be pushed, our little 'clearing' can never form more than an infinitesimal fraction of the 'boundless prairie.' No part of this, however, can strictly be called inaccessible to unaided human reason, if time and patience fail not. But far beyond in one sense, though in another sense ever intimately present with us, are the higher mysteries of the true Metaphysic, of which our senses and our reason, unaided, are alike unable to gain us any information."

While cordially indorsing these views, the writer of this notice would remark how admirably fitted is such a science as Physics for the discipline of the human mind. It possesses that boundlessness which is the *ultimate* characteristic of all true knowledge, and this is so obvious that few are bold enough to represent our "little Physical clearing" as bounded by an "impenetrable wall" or by the "abyss."

The scientific incendiary (to change the metaphor somewhat) prefers to confine himself to regions where there is a large collection of inflammable materials, until at length his attempts are brought to an end by the copious stream of cold water with which the physicist is able to deluge the scene of his exploits.

BALFOUR STEWART

OUR BOOK SHELF

Beiträge zur Kenntniss der Liasischen Brachiopodenfauna von Südtyrol und Venetien. Von Hyppolyt Haas, Dr. Phil., Privat-docent an der Universität Kiel. Mit 4 lithographirten tafeln. 4to. (Kiel: Lipsius und Tischer, 1884.)

THIS is one of the numerous works which have been published during the last half century on the fossil forms of Brachiopoda, that most ancient, abundant, and anomalous class of the Invertebrata. Dr. Davidson has devoted the greater part of a tolerably long life to the study of this exceedingly interesting group; and the volume of the Palæontographical Society's publications for the present year will complete and close his valuable labours on the fossil Brachiopoda of Great Britain. He has kindly furnished me with the following critical notice of Dr. Haas's work, the title of which is above given :—

"Dr. Haas describes in his memoir some 40 species of Liassic Brachiopoda, and of which number 12 are new. In four admirably drawn quarto plates he gives figures of 32 species. The Liassic Brachiopoda from South Tyrol and Venetia are very remarkable, and have in part been described and beautifully illustrated by Gemmellaro, Böckh, Uhlig, Meneghini, Canavari, Oppel, Zittel, and Schmid; *Waldheimia perforata*, Piette, and *Spiriferina rostrata*, Schl., being the only species out of the number that occur in the Liassic rocks of Great Britain. Dr. Haas's work adds much to our knowledge with respect to the Liassic Brachiopoda, and his descriptions have been carefully drawn up. In 1881 and 1882 Dr. H. Haas and Dr. Camille Petri published a very important work, entitled 'Die Brachiopoden der Juraformation von Elsass-Lothringen,' accompanied by 18 beautifully drawn quarto plates. In this work the authors describe some 92 species from the Lias and Inferior Oolite, and of which a large proportion occur likewise in our British rocks. It is to be hoped that Dr. Haas will continue his valuable researches among the Brachiopoda."

"Non meus hic sermo!"

J. GWYN JEFFREYS

Tricycles of the Year 1884. By H. H. Griffin. (London: L. Upcott Gill, 1884.)

WHATEVER improvement in health and strength may have resulted from the now prevalent exercise of cycling, there seems to be a mental improvement, for a knowledge of the science of mechanics is more widely spread, or at any rate there is a more general desire to understand this science in so far as its application to the bicycle and tricycle is concerned. For this reason such a book as Mr. Griffin's "Tricycles of the Year" is likely to be of value, for in it he describes in simple language most of the tricycles which can now be obtained, giving particulars of dimensions and weight, and other information which a cyclist may require.

It is a pity that many well-known machines are not so much as mentioned, among which are the "Rudge," the "Cheylesmore," and the direct-action machines. Is it that there has been no improvement in any of these since last year? If so, why should the "Oarsman" be omitted or some others be described at length?

The good qualities and advantages of each machine are set forth plainly enough, while the defects are left to be discovered by riders. The author has no doubt acted wisely here; it would be next to impossible in dealing with such a multitude of often similar machines to make comparisons which cyclists who hold opposite opinions would not consider unfair.

The action of parts that are peculiar to any machine is carefully described, figures being inserted where necessary to make the text more comprehensible. The general appearance which many tricycles present is shown by a series of woodcuts.

Bicycles are not discussed, as they form the subject of a corresponding work. C. V. B.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Chalk and the "Origin and Distribution of Deep-Sea Deposits"

I LOOKED forward with great interest to the conclusion of Messrs. Murray and Renard's "Origin and Distribution of Deep-Sea Deposits," hoping that some useful comparisons would